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MONOGRAPH OF THE CORYNELIACEAE

HARRY MORTON FITZPATRICK

(WITH PLATES 12-18, AND TABLE I)

The Coryneliaceae have not been critically investigated, and a monograph of the species of the world has never been prepared. Since the majority of the species occur only in tropical or subtropical regions they have been collected only occasionally. Consequently few even of the larger herbaria contain more than a meager representation of them. The present paper is based largely on material obtained through correspondence with students of mycology in many parts of the world. The investigation was begun in the summer of 1917 at the New York Botanical Garden when the specimens in the herbarium there were examined. Subsequently considerable additional material has been obtained from other American herbaria, and from many foreign sources. Marked good fortune has been experienced in obtaining type and other authentic specimens for study. The original material of almost every species has been examined. More than 130 specimens have been studied during the progress of the investigation, and the herbarium of the writer contains in excess of 80 numbers. Many institutions and individuals have cooperated in making available their herbarium and library facilities.

The writer wishes especially to acknowledge his obligation to Doctor W. A. Merrill, Doctor F. J. Seaver, and Doctor J. H. Barnhart of the New York Botanical Garden for their uniform courtesy and spirit of cooperation during his stay there. He is particularly indebted also to Professor W. G. Farlow, and Professor R. Thaxter who made available to him all the material in the herbarium at Harvard University. An excellent collection of twenty specimens from the herbarium of the Union Department of Agriculture at Pretoria, South Africa, was received from Miss Ethel M. Doidge. Additional interesting South African material was sent by Professor P. van der Bijl from the Natal

herbarium at Durban. Professor L. Romell mailed for examination seventeen specimens representing all the collections of Coryneliaceae in the herbarium of H. Rehm at Stockholm. He also forwarded from the herbarium of Sydow type material of *Corynelia carpophila* Syd., and *C. clavata* form *macrospora* Syd., and sent from the herbarium of the Royal Museum at Stockholm several valuable specimens including a portion of the original material of *C. oreophila* (Spegazzini) Starbäck. Mrs. Flora W. Patterson and Miss Vera K. Charles have made available all the material of the Coryneliaceae in the herbarium of the Bureau of Plant Industry at Washington, D. C., and Doctor Charles Fairman has loaned for examination all the material in his herbarium at Lyndonville, N. Y. The writer is also indebted to Professor L. Mangin, curator in the Museum d' Histoire Naturelle at Paris for type material of *Coryneliella consimilis* Hariot & Karsten; to Professor N. Patouillard of Neuilly-sur-Seine for type material of *Capnodium fructicolum* Patouillard; to Doctor A. D. Cotton of the Royal Botanic Gardens at Kew for type material of *Capnodium maximum* Berkeley & Curtis, *Sphaeronema subcorticale* Cooke & Ellis, and *Corynelia nipponensis* n. sp.; to Professor Carlos Spegazzini for authentic material of *Alboffia oreophila* Spegazzini; to Mr. Elam Bartholomew of Stockton, Kansas, for type material of *Corynelia brasiliensis* n. sp.; to Professor F. L. Stevens of Illinois University for type material of *C. clavata* var. *portoricensis* Stevens; to Professor S. F. Ashby, Microbiologist at Kingston, Jamaica, for type material of *C. jamaicensis* n. sp., to Doctor H. D. House of Albany, New York, for type material of *Caliciopsis pinea* Peck, to Professor O. Juel of Upsala, Sweden, for information concerning the type material of *Corynelia uberata* Fries and to Miss E. M. Wakefield of the Royal Botanic Gardens at Kew for information concerning the type material of *Corynelia tripos* Cooke and a specimen labelled *Mucor clavatus* in the herbarium of Linnaeus. Excellent material of various species has also been received from Professor G. Yamada, Morioka, Japan; Professor Elmer D. Merrill, Manila, Philippine Islands; Professor F. J. F. Shaw, Pusa, India; Mr. John A. Stevenson, Rio Piedras, Porto Rico; Professor Otto A. Reinking,

Los Banos, Philippine Islands; Mr. Edwin B. Copeland, Chico, California; Professor H. S. Jackson, Purdue University; Doctor E. W. Olive, Brooklyn Botanic Garden; and Professor H. H. Whetzel, Cornell University.

Through the courtesy of Mr. Percy Wilson, the writer was allowed to examine all of the mounted specimens of *Podocarpus* in the phanerogamic herbarium of the New York Botanical Garden, and more than a dozen specimens of *Corynelia* which had been accidentally collected were found there. Professor A. J. Eames of Cornell University examined in like manner all of the material of *Podocarpus* in the Gray herbarium at Harvard University and obtained several valuable specimens. A similar search was made by Doctor S. M. Zeller in the herbarium of the Missouri Botanical Garden, and by Miss Vera K. Charles in the herbarium of the National Museum at Washington, D. C. A considerable number of valuable specimens were obtained in this way and the writer wishes to express his appreciation of the aid given him in this search. All the possibilities known to the writer for obtaining material of the group for study have been exhausted, and he feels that no additional material, the examination of which would contribute materially to the completeness of this paper, is available to him. Nevertheless it is probable that in those tropical countries in which fungi have been little studied, other species of the group will be discovered. It is hoped that the publication of this paper will stimulate the search for these forms. Finally the writer wishes to express his indebtedness to Professor H. H. Whetzel for the suggestion that the monograph be prepared, and for aid and encouragement given during the progress of the investigation. Thanks are also due to Mr. W. R. Fisher for the care taken in the preparation of the photographs which illustrate the paper, and to Mr. C. E. Chardon who, under the writer's immediate direction, prepared the plate of drawings and the phylogenetic chart which occurs in the text.

SYSTEMATIC RELATIONS OF THE CORYNELIACEAE

The family Coryneliaceae was erected in 1891 by Saccardo (45) to embrace the two genera *Corynelia* and *Tripospora*. As orig-

inally constituted it contained only two species, *Corynelia uberata* Fries and *Tripospora Cookei* (Cooke) Saccardo. The family diagnosis reads: "*Perithecia, coriacea, atra, lageniformia, ostiolo elongato, apice perforato, dein late infundibuliformiter expanso.*" In 1895 Saccardo (45) included in the family the genus *Coryneliella* represented by the single species *C. consimilis* Hariot & Karsten.

Lindau (28) in his treatment of the Sphaeriales includes in the Coryneliaceae the three genera *Corynelia*, *Coryneliella*, and *Tripospora*, and states that each is monotypic. Subsequently, Saccardo (45) has recorded the discovery and description of several additional species of *Corynelia*. Lindau regards the family as closely related to the Cucurbitariaceae, and emphasizes the fact that the two are alike in having the perithecia seated on a stroma. In his discussion of the Coryneliaceae, he states that the perithecium is flask-shaped with a long neck dilated at the apex and provided with a broad funnel-shaped mouth. The flask-shaped character of the perithecium is used by him to separate the Coryneliaceae from the Cucurbitariaceae, the perithecium in the latter family being more or less definitely globose.

It will be noted that both Saccardo and Lindau describe the perithecium as ostiolate, and as typical, therefore, of the Sphaeriales. Their statements in this connection are evidently based largely on the observations of Winter (55) on *Corynelia uberata* and *Tripospora tripos*. Cooke (8), however, from the examination of material of *Corynelia uberata* was led to place the genus *Corynelia* in the Perisporiaceae between *Capnodium* and *Antennaria*, and states that the perithecium is "wholly closed, hence without a mouth and irregularly split."

The writer's own observations show that the Coryneliaceae lack the typical ostiolum present in the Sphaeriales, and he sees no reason for regarding the group as closely related to the Cucurbitariaceae. The perithecium on the other hand cannot be correctly described as lacking a mouth or as irregularly split. In all the known species of the perithecium in the young condition is wholly closed, but at maturity it ruptures at the apex in a definite manner. In certain of the species, which the writer believes to

represent the more primitive condition, the perithecium ruptures at maturity in such a manner that the apex becomes fimbriate-lacerate, the hyphal elements pulling apart and recurving to form a fringe about a funnel-shaped opening. In other species, which evidently represent a more specialized and higher type of development, the perithecium is definitely and deeply cleft at the apex. In some of these cases a single cleft is formed; in others, the apex of the perithecium splits in a radial manner, three or more definite lobes resulting. In *Corynelia tropica* a single deep cleft is formed accompanied by a more or less evident fimbriate-laceration of the two lobes. This species possesses, therefore, an intermediate type of dehiscence. Since in several species of *Corynelia* the line of dehiscence follows wholly evident and prominent grooves which exist in the perithecium, even in the young condition, the type of dehiscence can certainly not be termed indefinite. At the same time the term ostiolum has not been applied to an opening as large as that which results in this case where in some species the whole interior of the perithecium is exposed. It might be assumed that an approach to this condition is found in the Sphaeriales in the Lophiostomataceae where an elongated slit-like mouth is termed the ostiolum. In this case, however, the opening is absolutely definite and small and never enlarges to expose the interior of the perithecium as in some of the Coryneliaceae.

Two species, *Corynelia fruticola* and *Sorica maxima*, embraced in this monograph were originally described as members of the genus *Capnodium* of the Perisporiaceae. They differ from other species of this genus in their possession of a definite erumpent stroma and in the absence of aerial mycelium. Moreover the characters of their perithecia, asci, and spores indicate that they are closely related to the species embraced in the genus *Corynelia*. Nevertheless it is evident that not only the genus *Capnodium* but also certain other genera of the Perisporiaceae possess many characters in common with the Coryneliaceae, and it has become increasingly evident that the two groups are closely related. The species of *Caliciopsis* have not been previously considered as members either of the Perisporiaceae or the Coryneliaceae. They

are, however, certainly closely related to *Sorica maxima*, and this species in turn possesses so many characters in common with *Corynelia fructicola* that it cannot easily be excluded from the Coryneliaceae. The genera *Sorica* and *Caliciopsis* may perhaps be regarded as transition forms between the Perisporiaceae and the Coryneliaceae, but their possession of an erumpent stroma and the definite apical dehiscence of the perithecium makes necessary their inclusion in the Coryneliaceae as delimited in this monograph. The characters of their asci and spores indicate, moreover, a close relationship with the species of *Corynelia*.

The Perisporiales are separated from the Sphaeriales chiefly on the basis of the difference in the method of dehiscence of the perithecium. Lindau (28) states that in the Sphaeriales the perithecium is provided with a definite ostiolum, while in the Perisporiales there is developed either a more or less globose, cleistocarp perithecium completely inclosing the asci and at maturity irregularly dehiscent, usually through disintegration (Erysiphaceae, Perisporiaceae), or a shield-shaped, imperfectly developed perithecium in some species dehiscent at the center by a circular pore (Microthyriaceae). In some species of the Perisporiaceae, however, the perithecium dehisces more or less definitely at the apex either by a small number of radial splits forming prominent lobes or by the method of fimbriate-laceration characteristic of *Caliciopsis*, *Sorica*, *Tripospora*, and *Corynelia fructicola*. On the other hand a few species of the Chaetomiaceae and Sordariaceae of the Sphaeriales fail to develop the usual ostiolum and dehisce irregularly.

The most constant characteristic of the Perisporiales is the production of superficial perithecia on aerial mycelium. These fungi cannot be said to differ essentially in this respect, however, from the Chaetomiaceae or other lower groups of the Sphaeriales. Moreover in the Perisporiales the existence of such forms as *Oidiopsis taurica* (Salmon 46) shows that even in this group the mycelium is not necessarily always superficial. A consideration of all these facts concerning the method of dehiscence of the perithecium, combined with a comparative study of the general morphology of the fungi embraced in the Perisporiales raises the

question whether or not these forms really comprise a natural order. On account of the tropical distribution of many of the species our knowledge of the Perisporiaceae and Microthyriaceae is recognized to be very imperfect, and it may be safely assumed that further study will result in pronounced changes in their classification. It is possible that many of the species embraced in the Perisporiaceae are more closely related to the Sordariaceae and other lower Sphaeriales than they are to the Microthyriaceae, many of which in turn might well be relegated to the Phacidiales. The genus *Diplocarpon*, as pointed out by Wolf (56) may indeed be regarded as furnishing a transition to this group.

The Sphaeriales, on account of their possession of a definite ostiolum may be assumed to be more highly developed than the Perisporiales. Still it is probable that they had their origin in fungi similar to the Perisporiaceae, and perhaps developed from these along several different lines.

The Coryneliaceae as constituted in the present paper cannot be placed with entire satisfaction either in the Sphaeriales or in the Perisporiales as delimited by Lindau and other authors. The absence of superficial mycelium and the development of the perithecia on an erumpent stroma render them unlike the Perisporiales, while the absence of a true ostiolum excludes them from the Sphaeriales. The problem is further complicated by the existence in the single genus *Corynelia* of two distinct types of dehiscence. In this connection it should be noted that although the more primitive of the two sorts of dehiscence has its counterpart in certain of the Perisporiaceae, the other and clearly more specialized method is wholly unlike anything hitherto described for any of the pyrenomycetes. A consideration of all the available data in the light of the questions involved makes it evident that the grounds for the inclusion of the Coryneliaceae among the higher Sphaeriales in the neighborhood of the Cucurbitariaceae are wholly untenable. These fungi are clearly of an essentially different and more primitive type. They are probably more closely related to the Perisporiaceae than to any other group, and their development of a unique type of dehiscence indicates an ancient origin.

The incorporation of the Coryneliaceae in the Perisporiales will necessitate some widening of the limits of this order, but this is probably at present the most logical disposition of the group. Since all the species lack aerial mycelium and bear their perithecia and pycnidia on an erumpent stroma, they differ essentially from the Perisporiaceae and clearly comprise a separate family. When the forms included by Lindau in the Perisporiaceae are more critically studied and the method of dehiscence in all of them is clearly understood, it is probable that the line of separation between the two families can be drawn with greater definiteness than at present.

INTER-RELATIONSHIPS OF THE SPECIES WITHIN THE FAMILY

A comparative study of the various species in the family has led to some interesting conclusions concerning the phylogeny of the group as a whole. It has also made clear the general line of development of the more highly specialized species from the lower more generalized ones. The accompanying chart gives in detail the writer's conception of the evolution of these forms.

Certain characters of the ancestral stock from which the Coryneliaceae of the present arose are easy to surmise. These ancestral forms evidently resembled in many respects the fungi now included in *Capnodium*. They had acquired, however, a pronounced tendency toward the parasitic habit, possessed internal rather than aerial mycelium, and bore their perithecia in a caespitose cluster on a definite erumpent stroma. We may assume also that the perithecium was elongated in form, probably definitely stalked, and that dehiscence was apical and of the type termed fimbriate-lacerate. The perithecium was further characterized by the absence of paraphyses and by the production of broadly ovoidal, long-stipitate, 8-spored asci with unicellular, spherical to oval spores. The species of *Caliciopsis* regarded by the writer as the most primitive members of the group now extant, have departed from this type relatively little. Other members of the family apparently somewhat less primitive in type are *Sorica maxima*, *Tripospora tripos*, and *Corynelia fruticola*. These species have resulted from development along very different lines.

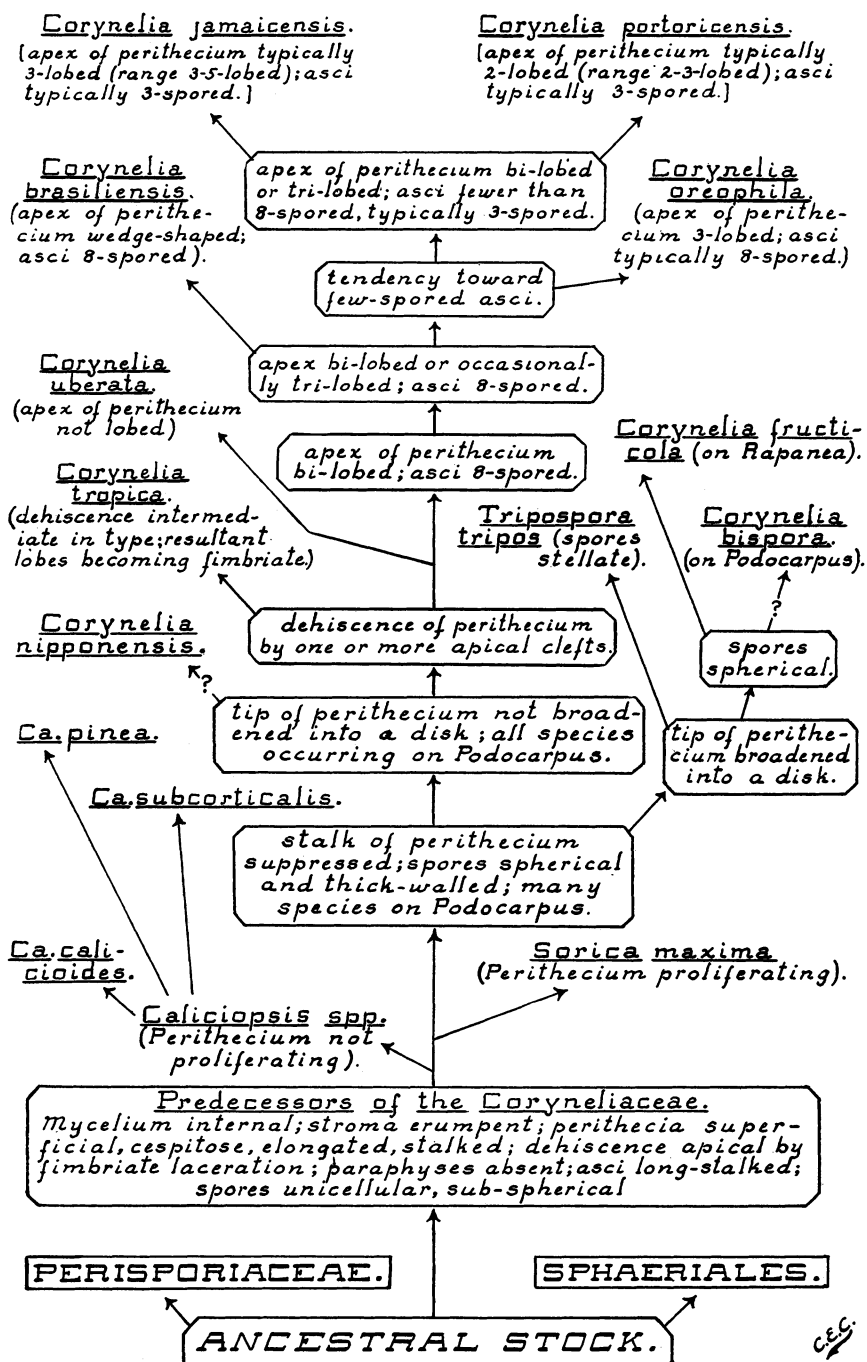


TABLE I

In *Sorica maxima* the perithecium resembles that in *Caliciopsis* but has the ability to proliferate in a remarkable manner, a new perithecium being developed at the tip of the old. In *Tripospora tripus* and *Corynelia fruticola* the perithecium dehisces as in *Caliciopsis* and *Sorica*, but the long stalk of the perithecium is absent, and in form and habit the species more closely approximate the more highly developed members of the group. These two species are remarkably similar in the general appearance of the perithecium, which is flask-shaped with a long, narrow neck dilated at the apex to form a broad, flat disc. They differ chiefly in the character of their spores. The existence of the peculiar stellate spores in *Tripospora tripus* is difficult to explain. No other species in the family shows a tendency toward the development of this stellate character, the brown, oval or spherical spores being remarkably similar throughout the group. The occurrence of *Corynelia fruticola* on *Rapanea* and the occurrence of *Tripospora tripus* on *Podocarpus* is noteworthy. Since all of the other species of *Corynelia* occur on *Podocarpus* it seems logical to conclude that the ancestral stock had become restricted to this host before the stellate spores of *Tripospora* appeared. Otherwise the occurrence of *Tripospora* on *Podocarpus* must necessarily be regarded as a coincidence.

The most primitive species in which dehiscence of the perithecium by an apical split occurs is probably *Corynelia tropica*. *Corynelia uberata* shows this type of dehiscence slightly more highly developed. In *Corynelia tropica* the apical split is accompanied by fimbriate-laceration of the resultant lobes, the transition to the more primitive condition thus being shown. Dehiscent perithecia of *C. bispora* and *C. nipponensis* have not been seen, but the probable position of these species in the phylogeny of the group as indicated by other characters is shown in the accompanying chart. In none of these species is the apex of the perithecium lobed.

It may be safely assumed that a perithecium definitely lobed at the apex shows in this respect a more recent modification than one with the more usual rounded apex. Following the same line of reasoning we may assume that a definitely 3-lobed apex repre-

sents a more recent development than a similarly 2-lobed one. In any case these assumptions make it possible to explain very satisfactorily the inter-relationships of the four known species which clearly represent the highest type of development in the genus *Corynelia*. These species (*C. oreophila*, *C. brasiliensis*, *C. portoricensis* and *C. jamaicensis*) are restricted, as far as is known, to the Western Hemisphere, and in all of them the upper portion of the perithecium is marked on the surface by one or more prominent grooves along which dehiscence takes place. They constitute a definite group of closely related species, and it is of interest to speculate concerning the character of the parent stock from which they arose. Here as in the more primitive species of *Corynelia* the asci were doubtless 8-spored. The perithecium was usually 2-lobed at the apex but occasionally a 3-lobed individual occurred. There was also the tendency for asci to occasionally bear less than eight spores, though this phenomenon was not common or pronounced. From this parent stock along one line *C. oreophila* arose by the increasing tendency toward the occurrence of 3-lobed perithecia. This species as it exists today is characterized by 3-lobed perithecia, though an occasional 2-lobed individual shows the retention of the ancestral character. The asci like those of the parent stock are 8-spored though occasional asci contain a smaller number of spores. From the parent stock along a neighboring line *C. brasiliensis* arose by the development on the perithecium of a wedge-shaped apex. In all other respects this species is like *C. oreophila*. The occasional occurrence on the stroma among the typical perithecia of a few small, poorly developed individuals with 2-lobed and 3-lobed apices exactly like those of *C. oreophila* constitutes reversion to the ancestral condition.

Along a third line *C. portoricensis* and *C. jamaicensis* arose from the parent stock by the increasing tendency for the asci to be few-spored. In *C. portoricensis* the form of the perithecium may be assumed to have changed relatively little. The majority of the perithecia are 2-lobed at the apex; a few are 3-lobed. The asci, however, have changed pronouncedly. The tendency seen in the parent stock for the number of spores in the ascus to de-

crease has been carried here to such an extreme that the asci are typically 3- or 2-spored. Occasionally 1-spored asci occur while less commonly asci with more than three spores are found. In *C. jamaicensis* similar conditions are found in the ascus, the tendency toward a 1-spored ascus being carried slightly farther and asci containing more than three spores being rarer than in *C. portoricensis*. The perithcium in *C. jamaicensis* has however changed also, the tendency in the ancestral stock for 3-parted perithecia to occur having been intensified here until 2-lobed individuals are no longer found. Moreover there is evident the tendency for occasional 4-lobed or even 5-lobed apices to appear, the change in the perithecium thus being even more pronounced than in *C. oreophila*, the species which *C. jamaicensis* most closely resembles externally. A study of the known geographical distribution of these four species is also instructive. The two species in which the 3-spored ascus is typical have been reported only from the West Indies, while the two species with typically 8-spored asci are continental having been found only in South America and Central America. On account of the high specialization both in the ascus and in the perithecium, *C. jamaicensis* is to be regarded as representing the highest point of development in the group.

HOST RELATIONSHIPS

The writer has attempted to determine whether or not the various species of *Corynelia* have become restricted to definite species of *Podocarpus*. The amount of material available for study has, however, been insufficient to warrant definite conclusions. Nevertheless the following facts should be recorded. The writer has studied material from twenty-one different species of *Podocarpus* and in only two cases has a single species been found to serve as a host for more than one species of the Coryneliaceae. Both *Tripospora tripos* and *Corynelia uberata* have been found on *Podocarpus elongata*, while *Corynelia oreophila* and *C. tropica* occur on *P. chilina*. In both of these cases the fungi are however of relatively distant relationship. Closely related species have not been seen on the same host. Moreover

a single species frequently occurs on several species of *Podocarpus*. Four hosts have been noted for *C. oreophila*, four for *C. tropica*, and seven for *C. uberata*. Since the genus *Podocarpus* contains a very large number of species and the writer's material of the Coryneliaceae is doubtless relatively limited, the above facts may, however, be found to explain themselves on the basis of coincidence.

SYSTEMATIC ACCOUNT

CORYNELIACEAE Saccardo, Syll. Fung. 9: 1073. 1891

Coryneliae Sacc., in Berlese et Voglino, Additamenta Sylloge Fungorum, p. 193. 1886.

Fungi typically parasitic (two little-known species, *Caliciopsis subcorticalis* and *C. calicioides*, described as saprophytic); stromata formed beneath the epidermis of the host from internal mycelium, later erumpent, black, coriaceous to carbonaceous, sharply demarcated, plane to pulvinate, usually small and scattered, rarely confluent; perithecia seated on the stroma or slightly buried in it, usually cespitose, black, elongated (flask-shaped, barrel-shaped, clavate, top-shaped, etc.), sessile or stipitate; apex either rounded and undifferentiated or variously sulcate and lobed, in some cases flattened into a broad disc, never possessing a typical ostium, at maturity dehiscent by a definite, wide opening resulting either from the formation of one or more clefts or by fimbriate-laceration; asci broadly ovate, very long-stipitate, thin-walled, evanescent, 1-8-spored, paraphysate; ascospores spherical to oval or in one species stellate; asexual spores, unicellular, elongated to allantoid, hyaline to slightly yellowish, borne in pycnidia which usually accompany the perithecia on the stroma.

KEY TO GENERA

A. Ascospores spherical to oval.

1. Perithecium definitely stalked.

a. Perithecium not undergoing proliferation to form a second perithecium at the apex of the first.....1. *Caliciopsis*.

b. Perithecium proliferating.....2. *Sorica*.

2. Perithecium not definitely stalked.....4. *Corynelia*.

B. Ascospores stellate.....3. *Tripospora*.

- I. CALICIOPSIS Peck, Ann. Rept. N. Y. State Mus. Nat. Hist. 33:
32. 1880

Hypsotheca Ellis and Everhart, Jour. Mycol. 1: 128. 1885.

Type species, *Caliciopsis pinea* Peck.

Stromata pulvinate, rounded to elongated, scattered or arranged in rather definite rows, occasionally confluent, formed within the host tissue but soon erumpent, bearing a cespitose cluster of perithecia and pycnidia; perithecium black, coriaceous to carbonaceous, stalked, not proliferating; the ascigerous swelling terminal to a sub-median but not basal, when sub-apical then terminated by a tapering beak, urceolate to sub-cylindrical; apex of perithecium at first closed, later a definite opening formed by fimbriate-laceration; asci ovate to clavate, long-stalked, thin-walled, evanescent, 8-spored, aparaphysate; ascospores varying from ellipsoidal or sub-fusiform to globose, crowded, smooth, brown, unicellular, thin-walled; pycnidia borne on the stroma with the perithecia, cespitose, sessile, globose to sub-globose, black, papillate, apically ostiolate; pycnosporos hyaline or in mass slightly yellowish, minute, unicellular, allantoid.

This genus is very closely related to *Sorica*. Dehiscence of the perithecium takes place in exactly the same manner in the two genera, and perithecia, pycnidia, asci, and spores are very similar in the two cases. The presence in *Sorica* of the phenomenon of perithecial proliferation is the only essential difference.

Peck (37) founded the genus on *C. pinea*, and states that the species is a discomycete and should be placed near *Cenangium*. He points out that, although in external appearance it resembles certain species of *Calicium*, it is wholly destitute of a thalline crust and gonidial cells, and must be regarded as one of the true fungi.

Ellis (10) in founding *Hypsotheca* states that the genus is clearly closely related to *Caliciopsis*, but, apparently influenced by Peck's statement that *Caliciopsis* is a discomycete, he fails to include it in North American Pyrenomycetes (Ellis 11). He places *Hypsotheca* in the Ceratostomeae on account of the beaked nature of the perithecium, and includes three species, *H. calicioides*, *H. subcorticalis*, and *H. thujina*.

Rehm (41) recognizes the identity of *Hypsotheca* and *Cali-*

ciopsis, and adopts the latter name for the genus. He incorporates it in the Calicieae treating this group as a subdivision of the Patellariaceae of the true discomycetes. He states that while it is apparently true that the majority of the Calicieae possess a more or less well developed lichen thallus, in certain species this has not been demonstrated and seems to be absent. These latter species, therefore, are treated as a group of the true fungi. Seven genera, *Calicium*, *Caliciopsis*, *Coniocybe*, *Sphinctrina*, *Cyphelium*, *Acolium*, and *Stenocybe* are included by him in the true discomycetes. It is evident that he is in error in incorporating *Caliciopsis* among these forms. Although the stipitate character of the fruit-body furnishes a point of similarity between *Caliciopsis*, *Calicium*, *Stenocybe*, *Cyphelium*, and *Coniocybe*, there exist important points of difference. The fruit-body of *Caliciopsis* is very certainly a perithecium, while in at least some of the other genera described by Rehm, it is just as surely an apothecium. The examination of Rehm's figures, and of such material as has been available, leads the writer to believe that with the exception of *Caliciopsis*, the other genera included here by Rehm are as stated by him, discomycetous in character. Certainly in the light of our present knowledge there is no reason for regarding them as closely related to the Coryneliaceae.

KEY TO THE SPECIES OF CALICIOPSIS

- A. Ascigerous cavity sub-apical, median or sub-median; perithecium beaked; species described as saprophytic on wood of deciduous trees.
 - 1. Ascospores $6-10 \times 3.5-5 \mu$; perithecium stout and short-stalked.
 - 1. *C. calicioides* (Figs. 35, 36, 47)
 - 2. Ascospores $4-5 \times 3-4 \mu$; perithecium slender and long-stalked.
 - 2. *C. subcorticalis* (Figs. 37, 38)
- B. Ascigerous cavity terminal; perithecium not beaked; species occurring on conifers; ascospores $3.5-6 \times 2-4 \mu$ 3. *C. pinea* (Figs. 33, 34, 48)

1. *Caliciopsis calicioides* (Fries) comb. nov.

- ?*Sporocybe calicioides* Fries, Syst. Mycol. 3: 340, 342. 1832.
Hypsotheca calicioides E. & E., Jour. Mycol. 1: 129. 1885.
Caliciopsis Ellisii Saccardo, Sylloge Fungorum, 8: 833, 834. 1889.
Hypsotheca caliciodes (Fr.) var. *caespitosa* Ellis in MS.

TYPE: Material labeled *Hypsotheca calicioides* E. & E. in the herbarium of Ellis at the N. Y. Bot. Gard. (collected by Suksdorf in Washington, and sent to Ellis by Sprague).

(Figures 35, 36, 47)

Mycelium in the cortical tissue of poplar, apparently saprophytic; stromata 500–1700 μ in diameter, more or less circular to elongated, scattered or developing in rather definite lines, which appear as concentric circles a few millimeters apart, adjacent stromata occasionally confluent; pycnidia and perithecia borne frequently on the same stroma, cespitose; perithecium shiny to dull, when young glabrous, in age becoming definitely roughened especially over the surface of the ascigerous swelling, 1400–1800 μ long, coriaceous, becoming brittle in age or on drying, consisting of a stalk, a median or sub-median enlargement containing the ascigerous cavity and a terminal beak; the enlargement sub-cylindrical-vesiculose, 270–480 μ long and measuring in lateral diameter at the middle 200–340 μ , not observed to collapse laterally as in the other species of the genus; the stalk 100–170 μ in diameter, relatively shorter and more rigid than in the other species, somewhat broadened at the base; beak at the beginning merely a short conical continuation of the ascigerous enlargement,¹ later more elongated, rigid and straight or sometimes curved, reaching in some cases 1 mm. in length, narrower than the stalk, 75–125 μ in diameter; the apex in the beginning sharp-pointed and closed, sometimes possessing a minute umbilicus which resembles superficially an ostium, at maturity becoming fimbriate-lacerate, the hyphal elements spreading apart and forming a broad, reddish-brown, fuzzy fringe around a central funnel-shaped opening; asci ovate to clavate, 15–20 \times 8–11 μ ; spores sub-fusiform to ellipsoidal to oval, 6–10 \times 3.5–5 μ (aver. 7 \times 3.5 μ); pycnidia 140 μ in diam.; pycnospores 2.5–3 μ long, hyaline or in mass slightly yellowish.

Ellis (10, 11) based his published descriptions of this species chiefly on the material collected by Suksdorf in Washington on poplar. He saw also, however, the material distributed by Ravenel,² and regarded the two collections as identical. The writer has examined material of both of these collections and also of an additional collection in the herbarium of Ellis labeled by him *Hypsotheca calicioides* (Fr.) var. *caespitosa* n. var.

¹ A double ascigerous enlargement forked at the upper end and bearing two beaks was present in one case as an interesting abnormality.

² Fungi Caroliniani I: 83.

This last collection was made in 1891, but Ellis makes no reference to it in North American Pyrenomycetes or in subsequent papers. In this material the stromata are broader than in the Suksdorf collection and the perithecia of a single cluster are consequently more numerous. The cespitose habit is present in both cases though in the Suksdorf material a single perithecium may sometimes occur alone on a small stroma. It is probable that the Suksdorf material is somewhat younger, especially since the ascospores are slightly smaller and lighter colored. In the material distributed by Ravenel the perithecia seem somewhat more slender than in the Suksdorf collection. The relatively small number of collections of material available for study renders these minor differences especially noticeable and in the present state of our knowledge there seems to be no better course than to incorporate the known material under the one species.

The species differs from *C. subcorticalis* especially in its stouter, more rigid perithecia and in its larger ascospores.

Ellis obtained the specific name for this species from the older binomial, *Sporocybe calicioides* Fries (13) which he cites as a synonym. The description published by Fries is, however, clearly based on a hyphomycetous fungus, and there seems to be no reason for assuming the two fungi to be the same. The original material of Fries is, according to Juel, not now present in the herbarium at Upsala, and has probably been lost. Since Ravenel² distributed material of the fungus of Ellis under the name *Sporocybe calicioides* Fries, this name is cited in the synonymy above with an interrogation mark.

MATERIAL EXAMINED

Ravenel's Fungi Caroliniani 1: 83 (specimen in herbarium Harvard Univ.); specimen collected by Suksdorf (No. 256) in Washington territory and sent to Ellis by C. G. Sprague, Dec., 1883. (Ellis Herb. N. Y. Bot. Gard.); specimen in Ellis' herbarium labeled in his handwriting *Hyphosybe calicioides* (Fr.) var. *caespitosa* n. var. (No. 71, March, 1891, on decaying poplar log).

2. Caliciopsis subcorticalis (Cooke & Ellis) comb. nov.

Sphaeronema subcorticale Cook & Ellis, Grev. **6**: 83. 1878.

Calicium ephemerum Zwackh, Lichenen Heidelbergs p. 81, 1883.

Hypsotheca subcorticalis (Cooke & Ellis) Ellis & Everhart, Jour. Mycol. **1**: 129. 1885.

Hypsotheca ephemera (Zwackh) Sacc., Syll. Fung. **10**: 72. 1891.

Caliciopsis ephemera (Zwackh) Rehm, Rabenhorst Kryptogamen Flora **1**³: 388. 1896.

ILLUSTRATIONS: E. & E. North American Pyrenomycetes *pl.* 22. *figs.* 1-5.

TYPE: Herb. Cooke, No. 2743, Royal Botanic Gardens, Kew. Portion of this deposited in Fitzpatrick herbarium as No. 1738

(Figures 37, 38)

Mycelium apparently saprophytic in the cortical tissue of oak; stromata small, approximately 0.3 mm. in diameter, scattered, usually hidden in the crevices of the bark, bearing a caespitose cluster of pycnidia and perithecia, the perithecia protruding at maturity from the crevices in the bark as minute, slender, black spines; perithecium glabrous, dull to shiny, reaching 1.5 mm. in length, when young probably coriaceous and white within, in age or in dried specimens becoming brittle and easily broken away, consisting of a long stalk, a median or sub-apical enlargement containing the ascigerous cavity,³ and a terminal beak; the enlargement sub-cylindrical-vesiculose, 200-325 μ long and reaching 150 μ in lateral diameter at the middle, sometimes laterally collapsed as in *C. pinea* but not inclined to one side as frequently happens in that species; the stalk long, slender, 80-125 μ in diam., cylindrical, straight to flexuous, swollen at the point of attachment to the stroma; beak of approximately the same diameter as the stalk, occasionally attenuated toward the tip especially when young, in some perithecia exceeding 500 μ in length, traversed by a narrow canal; the apex in immature stages sharp-pointed, closed, at maturity becoming minutely fimbriate-lacerate, and having a reddish-brown, fuzzy appearance, finally dehiscent, the terminal hairs spreading apart and forming a fringe around a definite opening; asci ovate to clavate, 12-15 \times 7-9 μ (p. sp.), spores ellipsoidal to oval or globose, 3-4 \times 4-5 μ ; pycnidia approximately 100 μ broad; pycnospores 2.5-3.5 μ long.

³ In the specimen of E. & E. N. A. F. 2nd series No. 2123 in Professor Thaxter's herbarium at Harvard University one abnormal and unusually long perithecial stalk was observed which had developed a half-dozen lateral buds, apparently containing ascigerous cavities.

Found by Ellis at Newfield, N. J., on loosened pieces of bark, on dry, decaying oak limbs lying on the ground. Reported by Rehm (41) from Heidelberg, Germany, on the young, lower branches of oak. Only the American material has been examined by the writer. In the present state of our knowledge there is no reason to assume that the species is parasitic. The material distributed by Ellis⁴ bears on the label of the packet the statement that the fungus is parasitic on old *Dichaena strumosa* Fr. on *Quercus coccinea*. An examination of the specimen leads the writer to feel that the presence of the *Dichaena* on the bark is merely incidental, and that there is no reason for assuming that the *Caliciopsis* is parasitic on it. The label accompanying the type material makes no reference to a parasitic condition or to *Dichaena*. Moreover Ellis makes no such reference in the published descriptions of the species (9, 10, 11). Only a very small amount of material has been available for examination, and the writer has not seen the species in nature. In as far as he is aware only the two collections made by Ellis at Newfield, N. J., in 1877 and 1883, are known for America.

Rehm (41) discusses this species under the name *Caliciopsis ephemera* (Zwackh) Rehm, though stating that he examined North American material⁴ of *Hypsotheca subcorticalis* and found it to be identical with *Calicium ephemerum* Zwackh.⁵ Since the description of *Sphaeronema subcorticale* C. & E. antedates that of Zwackh (57) by five years, it is clear that the specific name applied by Zwackh cannot be maintained. Rehm, however, states that Zwackh in his description of *Calicium ephemerum* cites *Stilbum rugosum* Fries and *Coniocybe Beckhausii* Körber (26) as synonyms. The papers of Zwackh and Körber are both unavailable to the writer, but according to Rehm, Körber failed to find asci in *Coniocybe Beckhausii*. A citation of the place of publication of *Stilbum rugosum* Fries is not given by Zwackh (57), Rehm (41), or Saccardo (45), and apparently an error has occurred in the publication of this name. Professor O. Juel states in a letter to the writer that no specimen bearing this

⁴ E. & E. N. A. F. 2nd series No. 2123.

⁵ Lichenes exsiccati No. 477.

name exists in the herbarium at Upsala, and that a careful search fails to disclose the use of the name in any of the writings of Fries. In the present state of our knowledge neither *Stilbum rugosum* Fries nor *Coniocybe Beckhausii* Körber can logically be included in the synonymy of the species here described. Although the writer has not seen a specimen of the material of *Calicium ephemerum* distributed by Zwackh,⁵ the name is included above in the synonymy because Rehm has seen this material and has pronounced it identical with the American specimens distributed by Ellis.

MATERIAL EXAMINED

Herb. Cooke, No. 2743 (*type* collection of *Sphaeronema subcorticale* C. & E., Royal Botanic Gardens Kew; fragment of this preserved as Fitzpatrick Herb. No. 1738); Ellis and Everhart, N. Am. Fungi, 2nd series, No. 2123 (Underwood Collection at N. Y. Bot. Gard.; also in Herb. R. Thaxter at Harvard Univ.).

3. CALICIOPSIS PINEA Peck, Ann. Rept. N. Y. State Mus. Nat. Hist. 33: 32. *pl.* 2. *figs.* 11-15. 1880, and in Bull. Torr.

Bot. Club 9: 62. *pl.* 24. *figs.* 8-12. 1882

Calicium stenocyboides Nylander, Flora 65: 451. 1882.

Cyphelium stenocyboides (Nylander) Arnold, Lichenes Monacenses Exsiccati, No. 417, 1895.

Caliciopsis stenocyboides (Nylander) Rehm, in Rabenhorst Kryptogamen Flora 1⁸: 389. *figs.* 1-4. 1896.

ILLUSTRATIONS: Peck, Ann. Rept. N. Y. State Mus. Nat. Hist. 33: *pl.* 2. *figs.* 11-15; Bull. Torr. Bot. Club 9: *pl.* 24. *figs.* 8-12; Rev. Mycol. 4: *pl.* 29. *fig.* 7; Rehm in Rabenhorst Kryptogamen Flora 1⁸: 383. *figs.* 1-4.

TYPE: In the herbarium of Peck at Albany, N. Y. Material of original collection also in herbarium at New York Botanical Garden. Both specimens studied by writer, and permanent slides showing mature asci, ascospores, and pycnospores deposited in his herbarium as No. 1688.

(Figures 33, 34, 48)

Mycelium parasitic⁶ in the trunk and branches of pine, causing the formation of sharply delimited, depressed areas (cankers) in the cortical tissue; these cankers frequently several inches in diameter and characterized by a smoother surface and more reddish color than the surrounding bark; stromata numerous, more or less definitely circular, scattered over the canker, several occasionally confluent, minute, scarcely visible, each entirely covered with a cespitose cluster of pycnidia and perithecia, 0.5–1.0 mm. in diameter, occasionally smaller bearing only one or two fruit-bodies; pycnidia usually preceding the perithecia, but both often found on the same stroma; perithecia appearing to the naked eye as fascicles of black spines arising from the surface of the bark; perithecium glabrous, dull to shiny, reaching 2 mm. in height, when young white within and coriaceous, in age or in dried specimens becoming brittle and easily broken off, long-stipitate, the ascigerous cavity developed within a terminal urceolate swelling which at maturity is frequently laterally collapsed, and curved or inclined to one side, resembling strikingly the capsule in certain mosses (genus *Hyponum*); occasionally the apex of the stalk forked and bearing two or even three terminal ascigerous swellings; the stalk long, reaching 1600 μ , slender, 100–140 μ in diam., cylindrical, either straight or definitely curved to one side, not flexuous, swollen at the base; the perithecium reaching almost its full length before the terminal ascigerous swelling is formed, and in immature stages appearing as a sharp-pointed spine of uniform diameter; the terminal enlargement at first clavate, 400 μ long \times , 175–275 μ wide, closed; at maturity the apex of the swelling becoming fimbriate-lacerate and assuming the reddish-brown, fuzzy appearance seen in several other members of the family, finally dehiscent, the terminal tuft of hairs spreading apart and forming a fringe around a definite opening; asci ovate, 12–17 \times 5–8 μ (p. sp.), spores ellipsoidal to ovoidal or globose, 3.5–6 \times 2–4 μ ; pycnidia 100–150 μ ; pycnosporos 2.5–3.5 μ long.

Parasitic⁶ on *Pinus strobus* in eastern North America. Found on *P. rigida* in New Jersey by Ellis, and reported from Germany by Rehm (41) on *Pinus pumilo* and on fir. The material on *Pinus pumilo* distributed by Arnold⁷ under the name *Cyphelium stenocyboides* has been examined by the writer and is

⁶ The statement that the species is parasitic is based wholly on field observations on *Pinus strobus*, and is not yet supported by artificial infection experiments.

⁷ No. 417 Lichenes Monacensis exsiccati.

identical with American material of *Caliciopsis pinea*. No material on fir has been seen by the writer, but Rehm reports its collection on this host at Heidelberg. One of the specimens⁸ cited by Rehm (41) has been unavailable to the writer and probably contains the material collected on fir.

MATERIAL EXAMINED

New York: *type* material collected at Charlton by Chas. Peck (in Peck Herb. Albany, N. Y.; also in Herb. N. Y. Bot. Gard.); Fitzpatrick Herb. Nos. 1664, 1665, 1669, 1726, and 1739 (material collected at various points near Ithaca).

New Jersey: Herb. C. E. Fairman No. 2004 (material collected Apr. 1889 at Newfield by Ellis on *Pinus rigida*; other material of same collection in Ellis Herb. at N. Y. Bot.); another specimen in Ellis Herb. collected by him at Newfield, Dec. 12, 1881, probably also on *Pinus rigida*.

Massachusetts: Material collected at Manchester by W. C. Sturgis, Oct. 1888 (Herb. C. E. Fairman No. 2002, and three packets at N. Y. Bot. Gard. labeled "ex. Herb. Seymour"); material collected by Sturgis at Manchester, Nov. 1888 (two packets at N. Y. Bot. Gard. labeled "ex. Herb. W. G. Farlow"); material collected by Sturgis at Manchester, Dec. 8, 1888 (E. & E. N. Am. Fungi No. 2382 in Herb. C. E. Fairman, and at N. Y. Bot. Gard.).

Pennsylvania: Herb. Fitzpatrick No. 1792 (material collected at Stone Valley, June 12, 1920).

Vermont: Herb. C. G. Pringle No. 300 (in Herb. W. G. Farlow at Harvard Univ., in Peck Herb. Albany, N. Y., and Fitzpatrick Herb. No. 1741). Material collected by Pringle at Charlotte.

Germany: Arnold, Lich. Monoc. Exsic. No. 417 (in Herb. Harvard Univ.) on *Pinus pumilo*.

2. SORCIA Giesenhagen, Ber. Deut. Bot. Gesell. 22: 191-196. *pl.* 13. 1904

Capnodiella Saccardo, Syll. Fung. 17: 621. 1905 (Syll. Fung. 1: 74. 1882, as subgenus).

⁸ v. Zwackh-Holzhausen, Lichenes exsiccati No. 686.

Type species, *Capnodium maximum* Berk. & Curt.

Stromata, black or dark-brown, formed within the living leaves of the host, later erumpent, bearing pycnidia and perithecia; perithecium black, coriaceous, very long-stalked, the ascigerous portion clavate, tapering into a long, beak-like neck traversed by a canal; apex at first closed but at maturity fimbriate-lacerate, a definite opening finally resulting; proliferation of the perithecium taking place after the escape of the ascospores, the stalk of a second perithecium arising as a continuation of the beak-like neck of the first and emerging from the opening at the tip of the beak; the second perithecium long-stalked and in every way identical with the first; by the repetition of this phenomenon as many as five perithecia formed in linear series; two perithecia occasionally arising from one opening, a definite fork thus being formed; asci ovate, very long-stalked, thin-walled, evanescent, 8-spored, paraphysate; ascospores spherical to sub-ellipsoidal, thin-walled, brown, unicellular; pycnidia borne on the stroma among the perithecia, sessile or short-stipitate, globose, black; pycnosporos hyaline, fusiform, unicellular.

Resembling *Caliciopsis* in asci, ascospores, pycnidia, and pycnosporos, and differing from that genus essentially only in the possession of the phenomenon of proliferation. The method of dehiscence of the perithecium is identical with that found in *Caliciopsis*, *Tripospora tripos*, and *Corynelia fructicola*.

The subgenus *Capnodiella* of the genus *Capnodium* Montagne was erected by Saccardo (45) to include the single species *Capnodium maximum* Berk. & Curt., which differs from other members of the genus in having unicellular ascospores. Later the subgenus, still containing the single species, was raised by him (Saccardo 45) to generic rank. Meanwhile Giesenhagen (15) studied material of the same fungus, and failing to recognize it as *Capnodium maximum*, founded the genus *Sorica* upon it. He named the species *S. Dusenii* but later (16) having learned of his error, changed the name to *S. maxima* (Berk. & Curt.) Giesenhagen. The genus *Sorica* is placed by him in the Sphaeriaceae-Phaeosporaeae of Saccardo, though he regards it as of doubtful relationships. He suggests the possibility of including it in the Xylariaceae or in the Ceratostomataceae. Von

Höhnelt (21) includes *Capnodiella* in his enumeration of the genera of the Capnodiaceae, but subsequently (22) states that the genus is in reality a member of the Coryneliaceae. He feels that it is closely related to *Corynelia*, differing from that genus chiefly in the long stalk of the perithecium. Finally Stevens (49) describes the fungus as new under the name *Corynelia pteridicola* Stevens. The writer has examined several collections of this fungus, and agrees with von Höhnelt and Stevens that the species should be included in the Coryneliaceae, but he feels that it differs sufficiently from all the known species of *Corynelia* to warrant its exclusion from this genus. The genus *Sorica* is therefore recognized for it. Patouillard and Gaillard (35) state that the species is closely related to *Capnodium arrhizum* Pat. & Gail., a fungus found by Gaillard in Venezuela on dead leaves lying on the ground. All the material of the original collection of this latter species was deposited in the herbarium of Gaillard, the collector. Patouillard has written to the writer stating that he has never had material of the species in his own herbarium, and that he does not know what became of the herbarium of Gaillard after the latter's death. The original material of *Capnodium arrhizum* must be considered, therefore, as unavailable if not actually lost. A study of the figures and description given by the authors of the species, has convinced the writer, however, that this fungus is very different from *Sorica maxima*, and clearly not a member of the Coryneliaceae.

I. *SORICA MAXIMA* (Berk. & Curt.) Giesenhagen, Ber. Deut. Bot. Gesell. 22: 355-358. 1904

Capnodium maximum Berk. & Curt., Jour. Linn. Soc. Bot. 10: 391. 1869.

Sorica Dusenii Giesenhagen, Ber. Deut. Bot. Gesell. 22: 191-196. pl. 13. 1904.

Capnodiella maxima (Berk. & Curt.) Saccardo, Syll. Fung. 17: 621. 1905.

Corynelia pteridicola Stevens, Illinois Acad. Sci. Trans. 10: 179-181. fig. 6. 1917.

ILLUSTRATIONS: Giesenhagen, Ber. Deut. Bot. Gesell. **22**: *pl.* 13. 1904; Stevens, Ill. Acad. Sci. Trans. **10**; *fig.* 6. 1917.

TYPE: in the herbarium of Berkeley, at the Royal Botanic Gardens, Kew, England; co-type material in the herbarium of Curtis at Harvard University. Both of these have been examined by the writer, and a portion of the type is deposited in his herbarium.

(Figures 30-32, 49)

Mycelium parasitic in the leaves of the host, localized, confined to a small area surrounding the point of infection, forming a definite stroma within the host tissue; stromata in some collections of material scattered irregularly over the leaf, in others confined to the sori, the general appearance of the fungus on the host in the two cases consequently very different; the stroma when formed in the sorus not well-developed, buried from sight below the mass of host sporangia, not spreading to the other host tissues, usually not forming a spot in the leaf, and never observed to result in its perforation; perithecia arising as black bristles among the host sporangia and radiating in every direction; stromata when formed in other portions of the leaf erumpent, usually hypophyllous, at first minute, gradually increasing in area, the central portion soon falling out, leaving only the opposite epidermis or more often a complete perforation; the hole thus formed in the leaf reaching 3-4 mm. in diameter, surrounded by an annular or ring-shaped stroma, less than 1 mm. in width, and of the thickness of the leaf or slightly thicker; stromata from the first bearing numerous pycnidia and perithecia; later when the hole appears in the leaf the perithecia forming a ring of bristles around the perforation and arising from the annular stroma on both the upper and lower surfaces; perithecium shiny to dull, 1-1.5 mm. long, stalk 35-50 μ thick, the ascigerous portion glabrous, 125-150 μ in diam. \times 250 μ in length, tapering into a glabrous beak-like neck, 200-350 μ long; stalk frequently hairy with brown hyphae; asci 15-17 \times 10 μ (p. sp.), ascospores 5-6 \times 4-5 μ ; pycnidia covered with brown hairs like those on the stalk of the perithecium; pycnospores 11-24 \times 4 μ .

Parasitic on *Polypodium* (*Campyloneurum*) *phyllitidis*, *P. punctatum*, *P. crassifolium*, *P. Schomburghianum* and probably other species in Cuba, Porto Rico, San Domingo, Brazil, Ecuador, Venezuela, and probably other neighboring countries.

Giesenhagen (15) states that the brown hairs which clothe the pycnidium and the stalk of the perithecium are conidial bearing

and he figures a cluster of very minute conidia at the tip of one of these hairs. His observations have not been corroborated by the writer.

Seven specimens of this fungus have been examined by the writer. In five of these the fungus occurs exclusively in the sori; in the other two, sori are absent and the stromata are scattered irregularly over the leaf. The general appearance of the fungus in the two cases is different, but the perithecia, asci, and spores are identical. Giesenhagen saw both forms of this species and suggests that the fungus more often occurs in the sorus because the outer wall of the epidermal cells of this structure in the young condition is thin and permits of easy penetration, while the cuticle covering the other cells offers greater resistance. He states that when the stromata are formed on the leaf outside of the sori they border wounds caused by biting insects. The observations of the writer and those of Stevens show that the holes in the leaf are caused by the advance of the fungus rather than by the biting of insects, and infection apparently occurs on the uninjured epidermis. The condition or age of the host at the time of infection probably determines the type of tissue attacked. It seems best in the present state of our knowledge to regard all the material as representing one species. It is of interest to record that the type material of Berkeley shows the fungus in the sori, while the original specimens upon which Stevens based his description of *Corynelia pteridicola* show the annular stromata scattered over the leaf surface.

MATERIAL EXAMINED

Porto Rico: Herbarium University of Illinois, Porto Rican Fungi No. 3551 (material cited by F. L. Stevens as the *type* of *Corynelia pteridicola*; communicated by him).

San Domingo: Herbarium of the Experiment Station of the Board of Commissioners of Agriculture, Rio Piedras, Porto Rico, No. 1021a (material collected April 7, 1913 by J. R. Johnston at La Romana, communicated by J. A. Stevenson, and deposited as Fitzpatrick Herb. No. 1528).

Cuba: Fungi Cubenses Wrightiani No. 786 (*type* material of *Capnodium maximum* B. & C. from the herbarium of Berkeley).

Kew, England; also *co-type* material from the herbarium of Curtis at Harvard University).

Brazil: Rehm, Ascomycetes No. 1817 (in herb. New York Bot. Gard.; also in herb. C. E. Fairman). See Ann. Mycol. 7: 138. 1909.

Ecuador: Herbarium of Patouillard (collected by Sodiro at Puente de Chimbo; communicated by Patouillard).

3. *TRIPOSPORA* Saccardo, in Berlese et Voglino, Additamenta Syll. Fung. p. 194. 1886

Type species, *Corynelia tripos* Cooke.

Stromata black, pulvinate, amphigenous and caulicolous, rounded to elongated, formed within the host tissue, later erumpent, not irregularly scattered, arranged definitely in rows and becoming confluent, bearing compact clusters of perithecia; perithecium flask-shaped with a globose to ovoidal ascigerous portion seated on the stroma and a long, cylindrical neck, which in the young condition is rounded at the apex and closed; at maturity the apex of the neck flattening into a disc which becomes fimbriate-lacerate; finally the margin of the disc recurving to give a wide funnel-shaped opening; asci as in *Corynelia*, ovate, long-stalked, thin-walled, evanescent, 8-spored, paraphysate; ascospores very characteristic, star-shaped, consisting of 4 (rarely 5) conical, sharp-pointed projections radiating from a rounded central portion, hyaline when young, becoming dark-brown, at maturity opaque and nearly black, thick-walled, unicellular.

Differing from *Corynelia* chiefly in the shape of the spores. The general appearance of the perithecium is very similar to that of *Corynelia fruticola*.

1. *TRIPOSPORA TRIPOS* (Cooke) Lindau, in Engler und Prantl, Die Natürliche Pflanzenfamilien 1¹: 413. 1897

Corynelia tripos Cooke, Grev. 8: 34. 1879.

Tripospora Cookei (Cooke) Saccardo, in Berlese et Voglino, Additamenta Sylloge Fungorum, p. 194. 1886.

ILLUSTRATIONS: Winter, Ber. Deut. Bot. Gesell. 2: figs. 1-3; Lindau, in Engler und Prantl, Die Natürliche Pflanzenfamilien 1¹: figs. 261 f. h. j.

TYPE: in herbarium of Cooke at Kew, England, Miss E. M. Wakefield has compared the type with the specimen of No. 3150

Rabenhorst-Winter, *Fungi europaei* at Kew, and states that they are the same, the latter being in fact co-type material. The writer has seen material of this *exsiccati* number in four different herbaria, and the accompanying photographs and drawings were made from that in the herbarium at Cornell University.

(Figures 22-25, 44, 45)

Stromata bearing a compact cluster of perithecia, $0.5-1.5 \times 0.5$ mm., not irregularly scattered, arranged definitely in rows and becoming confluent; these rows reaching sometimes a length of 10 mm. (15-20 mm. acc. Winter 55), but usually shorter, several rows frequently formed on the surface of one leaf; perithecia occurring on the stroma in a compact cluster of 2 to 16 (usually 4-8, and on isolated stromata radiating toward all sides, so oriented when the stromata form a row that they point to the left and right, the appearance of the fungus thus becoming regular and very beautiful; young perithecium definitely flask-shaped, with a roughened, spherical to ovoidal, ascigerous, basal portion and a long, cylindrical, glabrous, shiny neck which is rounded at the tip and blunt; the neck of the perithecium in early stages provided with a canal and marked at the apex with a minute umbilicus, but closed; in later stages the apex of the beak flattened to form a slightly convex disc, the diameter of which equals that of the ascus-bearing portion of the perithecium; this disc becoming fimbriate-lacerate, and assuming a reddish-brown, fuzzy appearance, finally definitely dehiscent, the margin recurving, exposing the lighter colored inner wall of the neck of the perithecium and resulting in the formation of a broad, funnel-shaped cavity, the center of which is usually filled with a black mass of spores; immature asci, $30-35 \times 40-60 \mu$ (p. sp.), mature asci containing opaque spores not observed; ascospores $22-34 \mu$ in diameter (measured from tip to tip, of adjacent projections).

Parasitic on the leaves and green parts of the stem of *Podocarpus elongata* and *P. Thunbergii* in South Africa, and of *P. Lambertii* in Brazil. Not known to the writer on other hosts or from other localities. The species has long been known from South Africa and is not uncommon there. It was collected in Brazil by Ule and recorded by Rehm (42). The material from Brazil available for examination differs from the South African material in having a slightly larger, rougher, and longer-necked perithecium. In other respects the two are alike.

Winter states that on account of the opaqueness of the mature ascospores it is not possible to determine whether the conical projections are cut off by septa from the rounded central portion. The writer has seen no indication of the presence of septa, and regards the spores as unicellular at all stages.

MATERIAL EXAMINED

Cape Province, S. Africa: Rabenhorst-Winter, *Fungi europaei* No. 3150 (*co-type*: one specimen in herb. Plant Path. Cornell Univ., two in herb. New York Bot. Gard., one in herb. Rehm, Stockholm, Sweden); Union Department of Agric., Mycological herb. No. 7355 (communicated by Ethel M. Doidge). Natal, S. Africa: herbarium Fitzpatrick No. 1563 (col. Miss A. V. Duthie, communicated by Doctor van der Bijl of Berea Durban). Brazil, S. America: herbarium Rehm Nos. 1744 and 1747 (col. Ule at Serra Geral, communicated by L. Romell of Riksmuseum, Stockholm, Sweden; fragment and slides preserved in Fitzpatrick Herb. as No. 1579).

(To be concluded in the September number)

EXPLANATION OF PLATES

PLATE 12

Corynelia portoricensis

Fig. 1. Clusters of perithecia on leaves of *Podocarpus coriaceus*. $\times 2\frac{1}{2}$.

Fig. 2. A caespitose cluster of perithecia arising from a single stroma. Various stages in the dehiscence of the perithecium are shown. $\times 11$.

Fig. 3. Two clusters of mature but unruptured perithecia. Near the center of each cluster a single trilobed individual occurs. $\times 11$.

PLATE 13

Fig. 4. *Corynelia brasiliensis*. A stellate cluster of mature but unopened perithecia. The stroma appears at the center of the cluster as a prominent cushion. $\times 11$.

Fig. 5. *C. brasiliensis*. Two coalescent clusters of perithecia. Near the center of each cluster the stroma appears as a prominent cushion. The perithecia show in practically every case the last stage of dehiscence. $\times 11$.

Fig. 6. *C. jamaicensis*. A cluster of unopened perithecia. Although the majority of the perithecia are trilobed, a single quadrilobed individual appears in the lower right hand portion of the figure. $\times 11$.

Fig. 7. *C. jamaicensis*. A cluster of old weathered perithecia. The individuals have all opened, and the 3-pronged apices resulting from the spreading of the lobes show clearly at the center of the figure. $\times 11$.

Fig. 8. *C. oreophila*. A stellate cluster of mature but unopened perithecia. The stroma appears at the center of the cluster as a roughened cushion. $\times 11$.

Fig. 9. *C. oreophila*. A more typical cluster of perithecia. At the center of the group the surface of the stroma appears greatly roughened, due to the fact that new perithecia are beginning to form where others were earlier broken away. None of the perithecia in this cluster are in reality bilobed. Those individuals which appear bilobed have an additional lobe hidden from view. For demonstration of this fact compare this figure with Fig. 12. $\times 11$.

Fig. 10. *C. oreophila*. A small group of perithecia, a single individual of which shows clearly the type of dehiscence characteristic of the species. $\times 11$.

Fig. 11. *C. oreophila*. A stroma bearing seven perithecia, one mature, six immature. The tips of two of the young individuals have been broken away, exposing their white interiors. $\times 11$.

Fig. 12. *C. oreophila*. The same cluster of perithecia shown in Fig. 9 photographed from a different angle. A careful comparison of the two figures will show that none of the perithecia are in reality bilobed. $\times 11$.

PLATE 14

Fig. 13. *Corynelia uberata*. Clusters of perithecia on leaves of *Podocarpus Thunbergii*. $\times 2\frac{1}{2}$.

Fig. 14. *C. uberata*. Clusters of immature perithecia. The tips of several individuals crushed and broken over in the lower cluster. $\times 11$.

Fig. 15. *C. uberata*. A cluster of almost mature but unruptured perithecia, the apex of each traversed by several deep furrows. Dehiscence occurs later along the line of the middle furrow. $\times 11$.

Fig. 16. *C. uberata*. A similar cluster of perithecia, but with many individuals broken away, exposing their white interiors. $\times 11$.

Fig. 17. *C. uberata*. A small group of perithecia several individuals of which are wholly mature and show clearly the characteristic method of dehiscence by a single deep apical cleft. $\times 11$.

Fig. 18. *C. uberata*. A copy of one of the illustrations published by Acharius in connection with the original description of this species in *Observationes Mycologicae* of Fries. Compare with Fig. 16. Magnification of original figure not given, but reproduced here as published.

Fig. 19. *C. nipponensis*. A cluster of mature but unruptured perithecia. Ruptured perithecia have not yet been seen but the presence of a single definite transverse furrow at the apex in many individuals indicates a type of dehiscence similar to that in *C. uberata*. $\times 11$.

PLATE 15

Fig. 20. *Corynelia fructicola*. Numerous perithecia arising from stromata on the surface of a fruit of *Rapanea melanophloeos*. The stromata stand close together and tend to form a crust which frequently covers the whole sur-

face of the fruit. In this case the portion of the fruit most densely covered with stromata is equatorial. Many of the perithecia here visible at the periphery have the fuzzy terminal disc indicative of maturity. Compare with the same stage in *Tripospora tripos* shown in Figs. 23 and 25. $\times 11$.

Fig. 21. *C. fruticicola*. Same as Fig. 20 but showing clearly a cluster of immature perithecia at the top of the figure. In these the terminal disc has not yet been formed. $\times 11$.

Fig. 22. *Tripospora tripos*. Clusters of immature perithecia on both surfaces of the leaf of *Podocarpus elongata*. The stroma shows clearly at the center of each cluster. $\times 11$.

Fig. 23. *T. tripos*. Cluster of mature perithecia showing the fuzzy terminal discs indicative of maturity. Compare with same stage in *Corynelia fruticicola* in Fig. 20. $\times 11$.

Fig. 24. *T. tripos*. Mature and dehiscent perithecia. The apex of the perithecium appears as a funnel with a fuzzy brown margin and a throat filled with a black powder consisting of the spores. $\times 11$.

Fig. 25. *T. tripos*. A few perithecia of the same age as those pictured in Fig. 23 shown in lateral view. $\times 11$.

PLATE 16

Fig. 26. *Corynelia tropica*. A group of mature but unruptured perithecia. Material collected in Chile. $\times 11$.

Fig. 27. *C. tropica*. A more elongated group of perithecia. Material a portion of the type collection (No. 1261. Rabenhorst, Fungi europaei) from Chili. $\times 11$.

Fig. 28. *C. tropica*. A cluster of mature ruptured perithecia. The type of dehiscence is similar to that in other species in which a single apical cleft occurs, but here the resultant lobes have the fuzzy character of the disc in *Tripospora tripos*. Material collected in Chili. $\times 11$.

Fig. 29. *C. tropica*. Clusters of immature perithecia from a collection of material made in the Philippine Islands. $\times 11$.

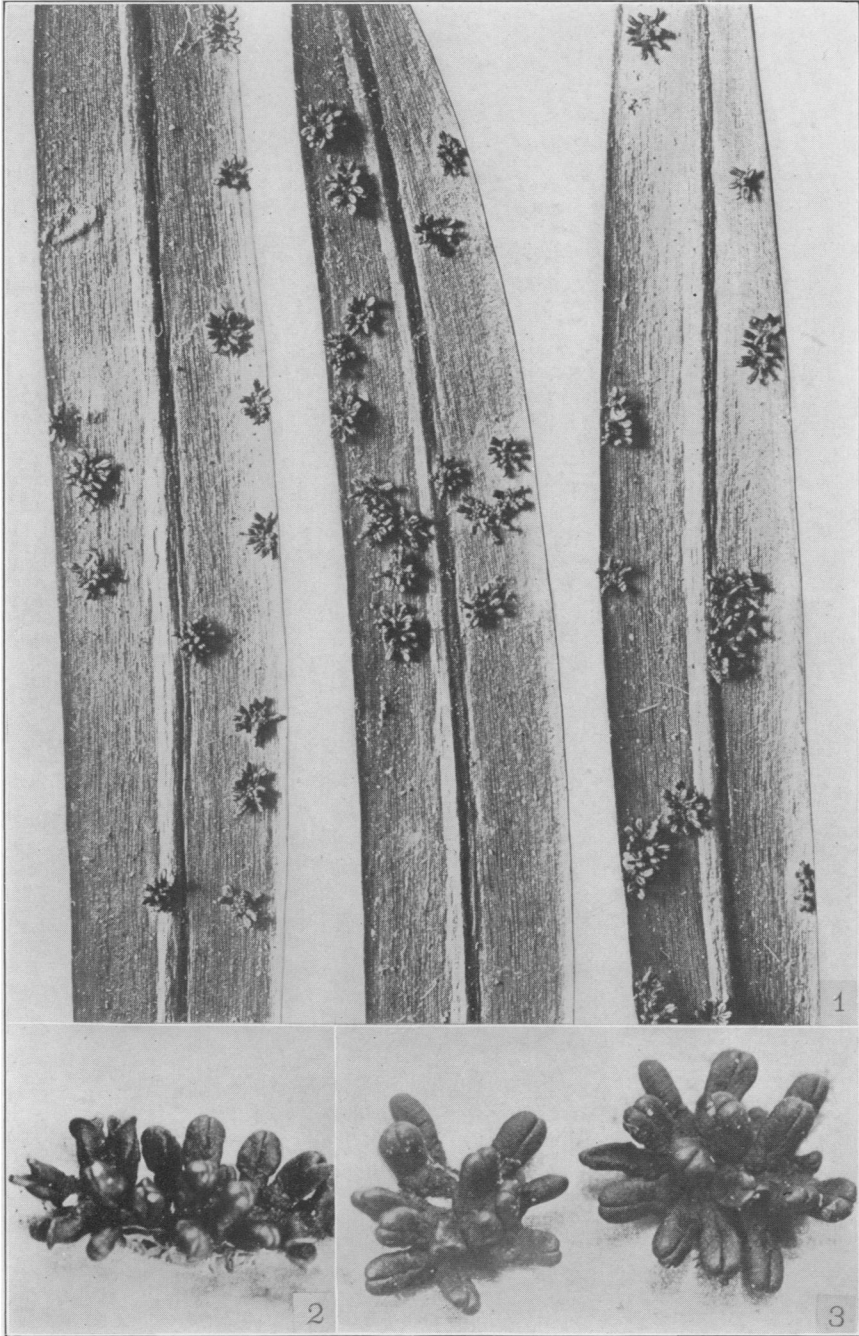
Fig. 30. *Sorica maxima*. Perithecia arising from an annular stroma bordering a perforation in the frond of *Polypodium*. As a result of proliferation several perithecia may be seen in linear series. Material photographed is a portion of the original collection on which Stevens founded *Corynelia pteridicola*. $\times 11$.

Fig. 31. *S. maxima*. Perithecia arising from a stroma at the base of a sorus of sporangia on the leaf of *Polypodium*. These are the primary perithecia and proliferation has not yet taken place. Material photographed distributed by Rehm (Ascomyceten No. 1817) as *Capnodiella maxima*. $\times 11$.

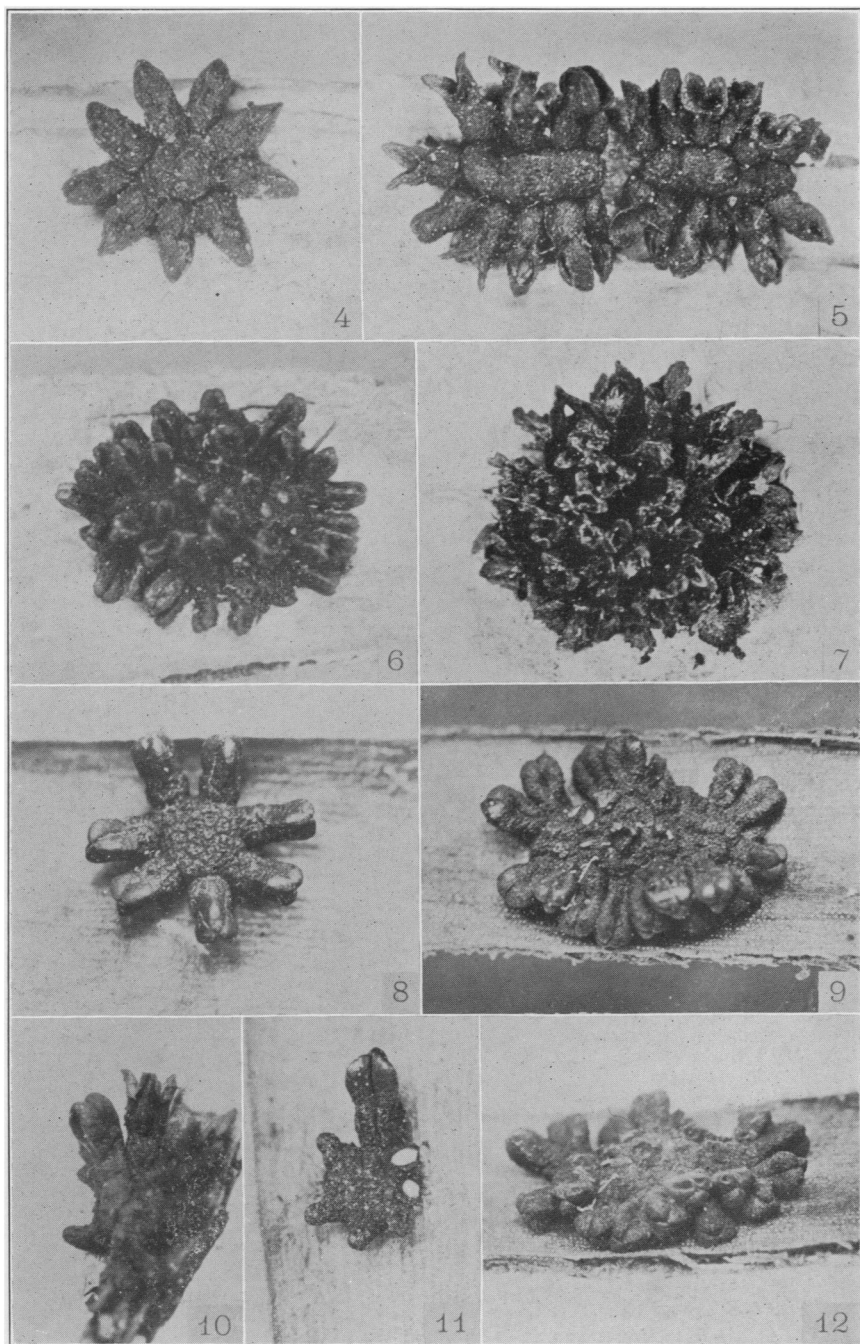
Fig. 32. *S. maxima*. Perithecia arising from a stroma at the base of a sorus of sporangia on the leaf of *Polypodium*. As a result of proliferation several perithecia are here shown in linear series. Material from Patouillard collected by Sodiro in Ecuador. $\times 11$.

PLATE 17

Fig. 33. *Caliciopsis pinea*. Perithecia arising from stromata on the bark of *Pinus strobus*. Type material from herbarium of Peck. $\times 11$.



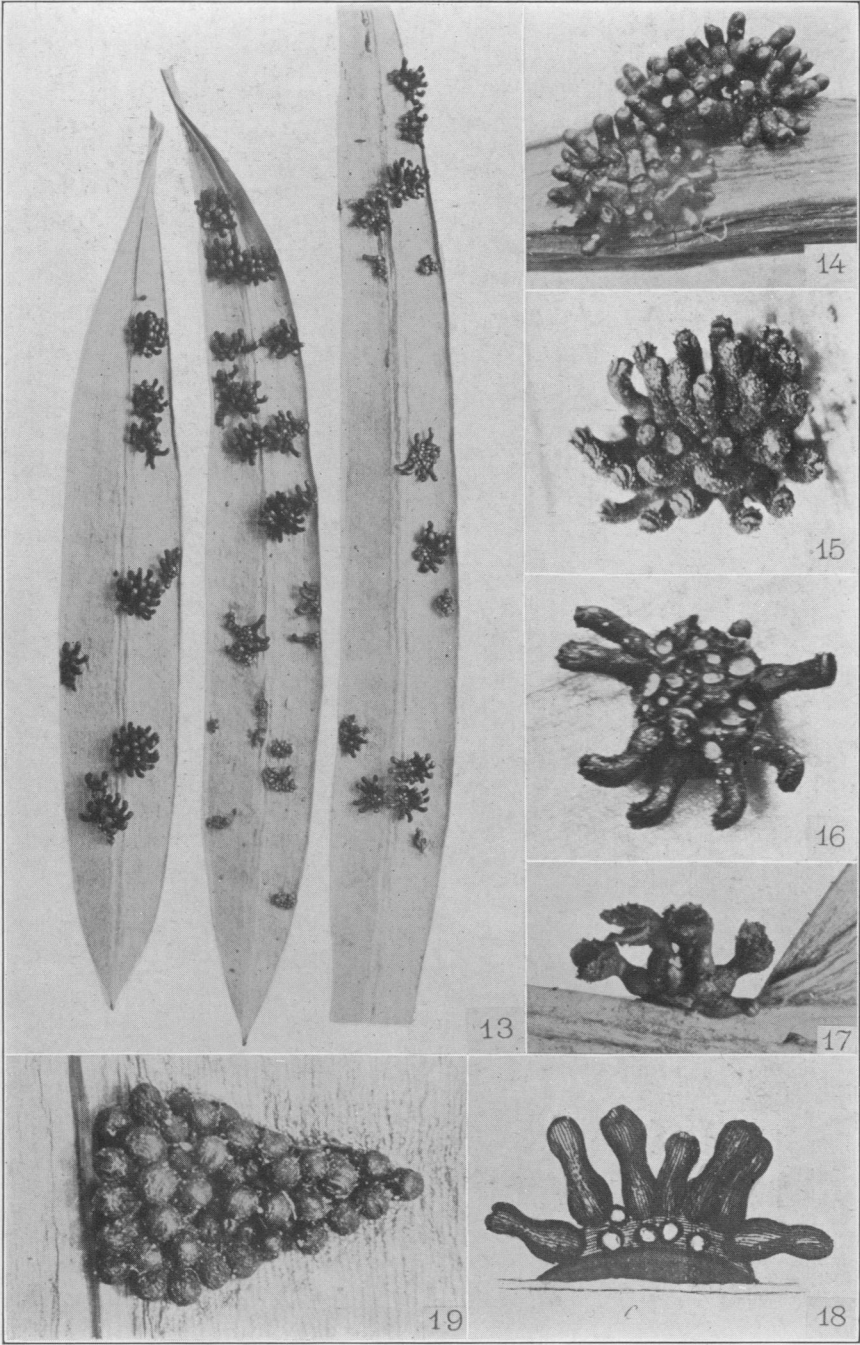
1-3. *CORYNELIA PORTORICENSIS*



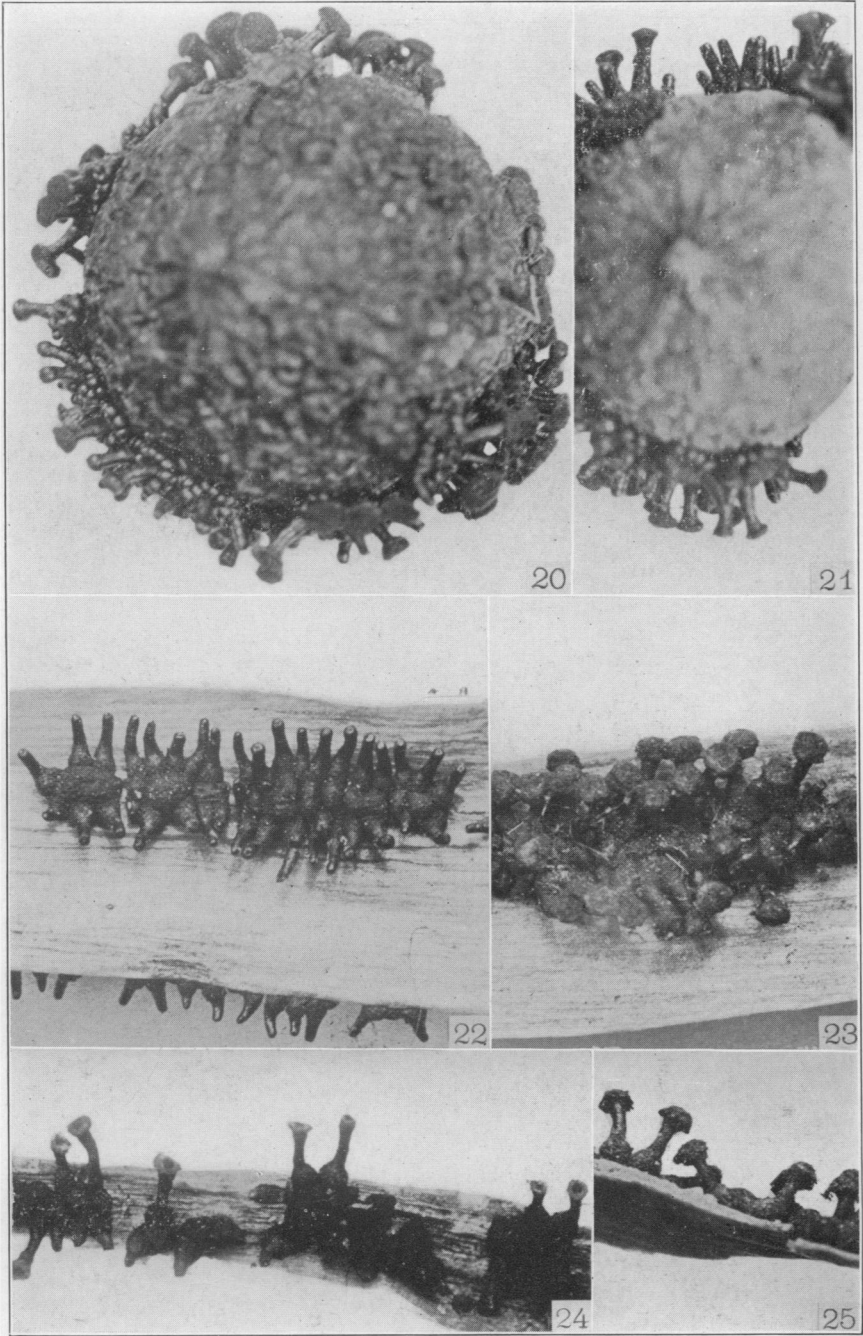
4, 5. *CORYNELIA BRASILIENSIS*

6, 7. *CORYNELIA JAMAICENSIS*

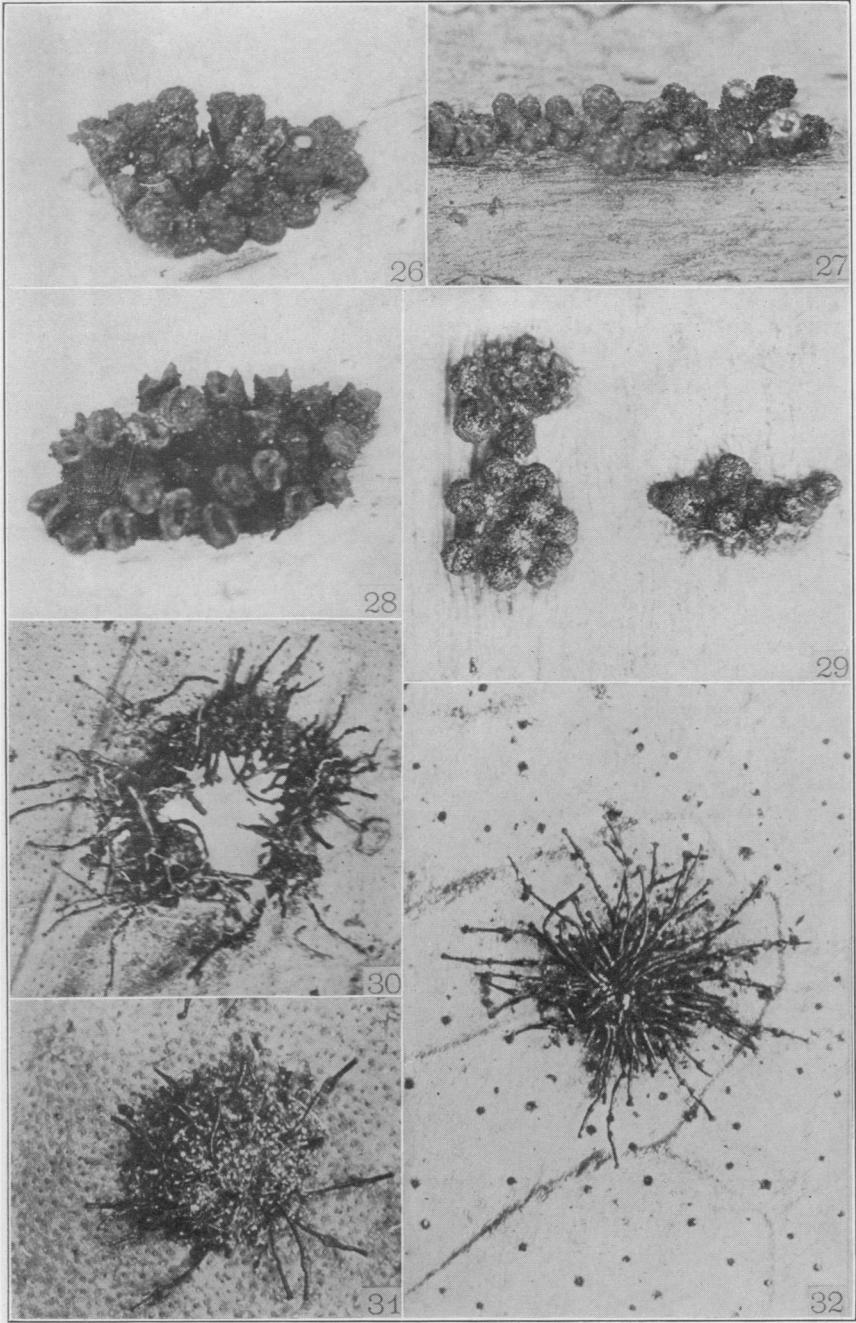
8-12. *CORYNELIA OREOPHILA*



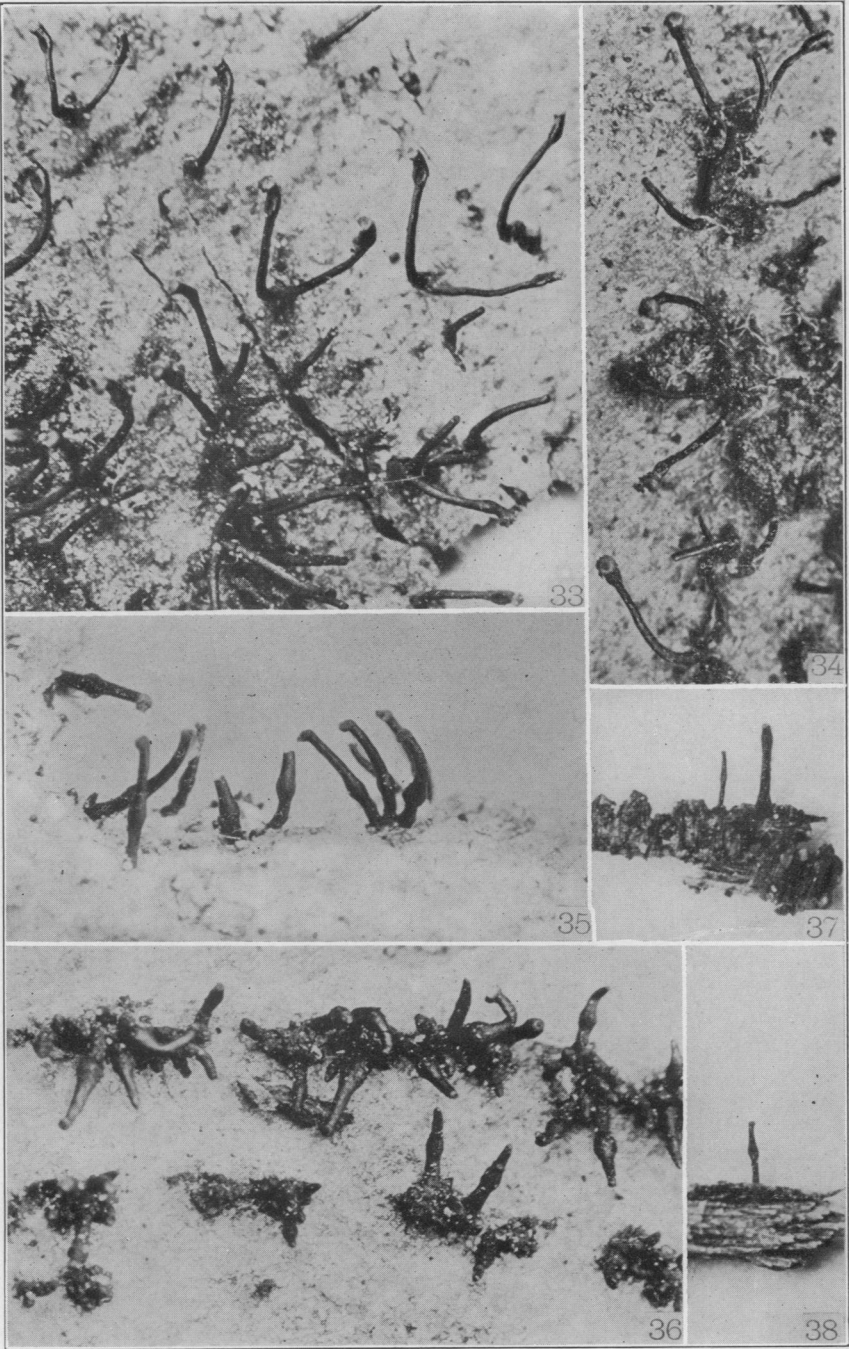
13-18. *CORYNELIA UBERATA*
19. *CORYNELIA NIPPONENSIS*



20, 21. CORYNELIA FRUTICOLA
22-25. TRIPOSPORA TRIPOS



26-29. *CORYNELIA TROPICA*
30-32. *SORICA MAXIMA*



33, 34. *CALICIOPSIS PINEA*
35, 36. *CALICIOPSIS CALICIOIDES*
37, 38. *CALICIOPSIS SUBCORTICALIS*

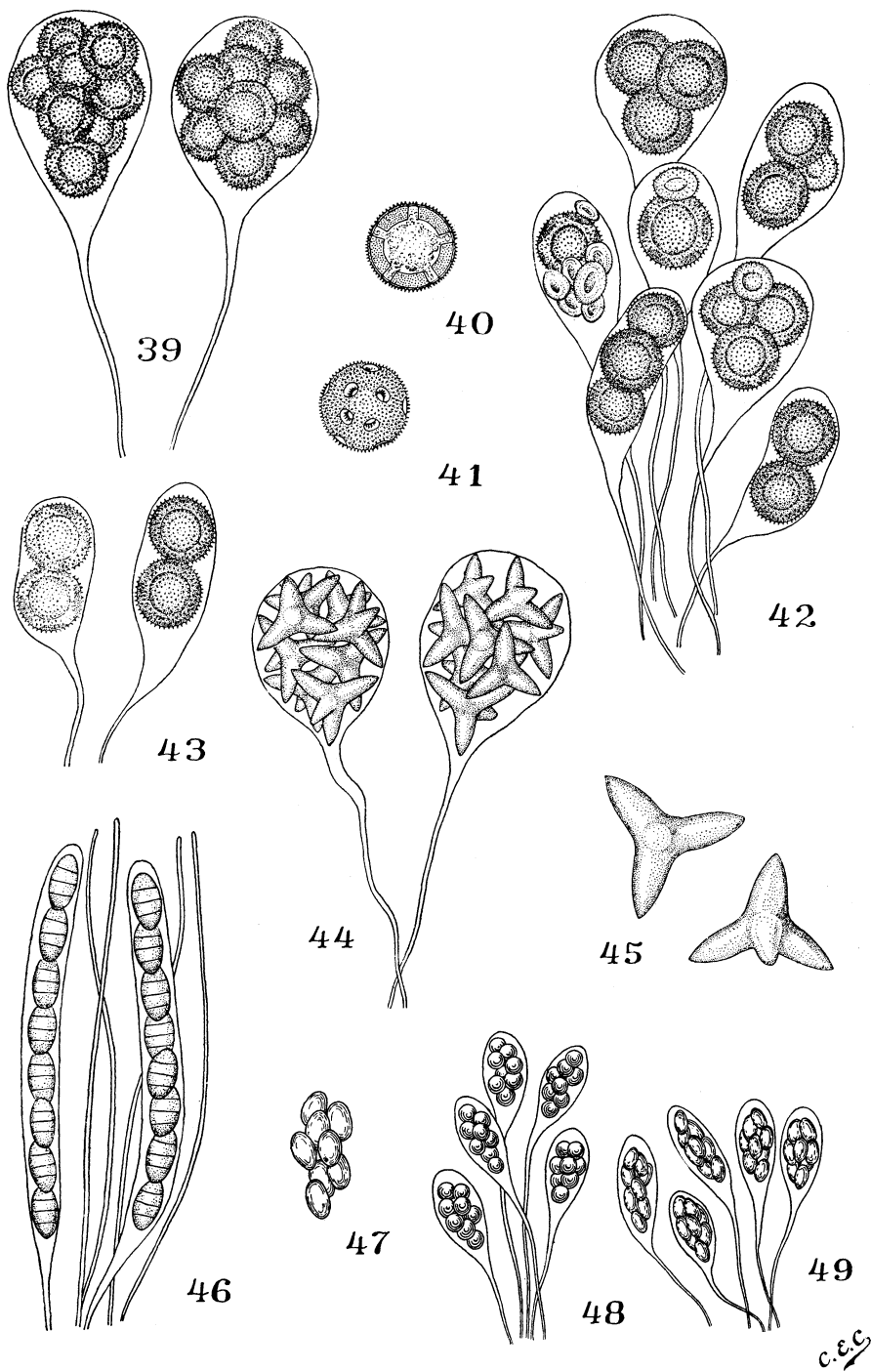


Fig. 34. *C. pinea*. Mature perithecia showing method of dehiscence. Compare lowest perithecium with those of *Tripospora tripus* in Fig. 24. $\times 11$.

Fig. 35. *C. calicioides*. Perithecia arising from stromata on bark of poplar. Type material collected in Washington by Sprague. $\times 11$.

Fig. 36. *C. calicioides*. Perithecia arising from stromata on bark of decaying poplar log. Material labeled in herbarium by Ellis as "var. caespitosa." $\times 11$.

Figs. 37 and 38. *C. subcorticalis*. Perithecia arising from stromata on bark of oak. Type material from herbarium of Berkeley. The cespitose character lacking here was observed in other specimens not available for photographing. $\times 11$.

PLATE 18

The drawings were outlined by the writer with the aid of a camera lucida. The details were then filled in under his immediate direction by his assistant Mr. C. E. Chardon. A Bausch and Lomb 1.9 mm. oil immersion objective and a 7.5 ocular were used. As reproduced Fig. 39 and figures 42-49 represent a magnification of about 700. Figs. 40 and 41 represent a magnification of about 1000.

Fig. 39. *Corynelia oreophila*. Typical 8-spored asci containing mature spores.

Fig. 40. *C. oreophila*. A single ascospore shown in median optical section. Note the thin echinulate episporium, the thick endospore, and the germ-pores. Somewhat diagrammatic.

Fig. 41. *C. oreophila*. A single ascospore shown in surface view. The drawing represents the germ-pores as opening through the episporium to the outside, and in this respect is diagrammatic, since the episporium covers the pore until the time of germination.

Fig. 42. *C. portoricensis*. A group of asci containing mature spores. Note the variation in the shape of the ascus, and in the number of spores in an ascus.

Fig. 43. *C. bispora*. Typical 2-spored asci containing mature spores.

Fig. 44. *Tripospora tripus*. Immature asci.

Fig. 45. *T. tripus*. Two mature spores.

Fig. 46. *Coryneliella consimilis*. Asci and paraphyses. Ascospores mature.

Fig. 47. *Caliciopsis calicioides*. A group of eight mature ascospores.

Fig. 48. *C. pinea*. A cluster of asci containing mature spores. In this species the ascospores are sometimes sub-globose or broadly oval.

Fig. 49. *Sorica maxima*. A cluster of asci containing mature spores.